Notice No.1

Rules and Regulations for the Construction and Classification of Submersibles & Diving Systems, July 2016

The status of this Rule set is amended as shown and is now to be read in conjunction with this and prior Notices. Any corrigenda included in the Notice are effective immediately.

Please note that corrigenda amends to paragraphs, Tables and Figures are not shown in their entirety.

Issue date: June 2017

Amendments to	Effective date
Part 1, Chapter 2, Sections 1 & 2	1 July 2017
Part 1, Chapter 3, Section 2	1 July 2017
Part 3, Chapter 1, Applicable Unit Types, Sections 1 & 5 (New), 9, 10, 11 & 12	1 July 2017
Part 4, Chapter 1, Section 2	1 July 2017
Part 5, Chapter 3, Section 2	1 July 2017
Part 5, Chapter 4, Section 3	1 July 2017
Part 6, Chapter 1, Sections 7 & 9	1 July 2017
Part 8, Chapter 1, Sections 1 to 10 (New)	1 July 2017

Part 1, Chapter 2
Classification Regulations

■ *Section 1*
Conditions for Classification

1.1 General

1.1.7 ~~The Rules are framed on the understanding that submersibles systems~~ Submersibles which have integral hyperbaric chambers will be operated with a ~~de~~compression chamber available ~~in~~ on the support vessel or installation. ~~Chamber~~ These compression chambers can be used ~~for~~ in dealing with cases of illness ~~should there be an~~ or emergency conditions when the submersible is operating its hyperbaric chamber at internal depths ~~in excess of~~ greater than 10 m.

■ *Section 2*
Character of Classification and Class Notations

2.2 Definitions

2.2.11 **An Atmospheric Diving Suit (ADS)** is a tethered one man submersible in which the operator's arms, or arms and legs, move inside articulated joints to provide mobility and protection to carry out the underwater task. The operator is not subject to a pressure greater than 100 millibars above atmospheric pressure.

2.2.12 **An Atmospheric Diving Suit System (ADS System)** includes the ADS and associated support components/systems such as support stands, access and service platforms, the handling system and the ADS control station.

2.3 Other Definitions

(*Part only shown*)

2.3.1 Other definitions appropriate to these Rules are as follows:

- **Autonomous units:** ~~Unmanned underwater vehicle, remotely controlled from a surface support facility which is used to monitor and control the vehicles functions.~~ Submersible craft which although manned in some cases, are designed to operate without physical connection to surface support vessel.

2.4 Character Symbols

(*Part only shown*)

2.4.2 A full list of character symbols for which submersibles, diving systems and deck compression chambers may be eligible is as follows:

100ASE	These characters will be assigned at the time of classing to a deck compression chamber in compliance with the Rules and Regulations and to the satisfaction of the Committee. The equipment may be static or ship borne and is to be maintained in a good and efficient condition. The equipment may have been classed originally with a particular submersible but is no longer associated with it. Alternatively, the Owner may have requested separate classification of such equipment as spare units or for other reasons acceptable to the Committee.
✠ 100AT ADS	These characters will be assigned to a new ADS constructed under LR's Special Survey, and in accordance with LR's Rules.
✠ 100AT ADS System LA	These characters will be assigned to a new ADS System constructed under LR's Special Survey, and in accordance with LR's Rules.
LA	These character letters will be assigned to all diving systems where the lifting appliance is considered to be an essential feature, and is mandatory. *See Part 5, Chapter 7 Lifting Appliances*.

Part 1, Chapter 3
Periodical Survey Regulations

■ *Section 2*
Periodical Surveys

2.4 Special Surveys (Manned and unmanned submersibles, containers, diving systems or deck compression chambers)

2.4.1 Prior to the commencement of the Special Survey, a meeting is to be held between the attending Surveyor(s), the Owner/Owner's representative and the thickness measurement company representative so as to ensure the safe and efficient conduct of the survey and thickness measurements to be carried out. In preparation for the survey and thickness measurements and to allow for a thorough examination, some removal of insulation may be required.

2.4.2 Thickness measurements are normally to be taken by means of ultrasonic test equipment and are to be carried out by a firm approved in accordance with LR's *Approval for Thickness Measurement of Hull Structure*.

2.4.3 The survey will not be considered complete until all required thickness measurements have been carried out. Such measurements are to be witnessed by the Surveyor(s) to the extent necessary to control the process.

~~2.4.1~~ 2.4.4 At the Special Survey the Surveyors are to complete the tests and inspections required at Annual Surveys ~~/~~, *see Pt 1, Ch 3, 2.1 Annual Surveys (Manned submersibles and chambers)*, and are to undertake all the tests and inspections required to establish to their satisfaction, the condition and operation of the unit as a whole. The Owner is to provide proper facilities for the survey to permit thorough inspection of the shells, fittings and attachments. Important equipment is to be opened up, as necessary, for inspection.

~~2.4.2~~ 2.4.5 Acrylic viewport windows are to be dismounted and examined for incipient cracks. Window seating~~'~~s are to be examined for corrosion~~;~~. Unless otherwise agreed, the windows should be renewed at 10 year intervals.

Existing paragraphs 2.4.3 to 2.4.5 have been renumbered 2.4.6 to 2.4.8.

(*Part only shown*)
~~2.4.6~~ 2.4.9 Following examinations and tests to be carried out:

(c) Pressure chambers and pressure hulls, except those located permanently under the sea, are, unless otherwise approved, to be subjected to over pressure tests generally to the level applied at the time of manufacture. In the case of a deck compression chamber, diving bell or other type of submersible, which may be subjected to external or internal pressure, either directly or due to differential pressure between compartments, over pressure tests are to be applied appropriate to the modes of service ~~pressurization~~ pressurisation. Prior to a pressure test, any delicate equipment that might be damaged by the test pressure should be removed or protected otherwise. Pressure tests may be hydrostatic or pneumatic. In the latter case the test pressure should be 1.1 times the maximum working pressure and conditions are to be in accordance with the requirements of a design pressure vessel code, including measures to protect personnel;

(m) Pressure vessels and apparatus not capable of satisfactory internal inspection and those whose satisfactory condition cannot be definitely established by internal inspection are to be inspected by another non-destructive method of examination or are to be subjected additionally to a hydraulic pressure test~~;~~.

Existing paragraph 2.4.7 has been renumbered 2.4.10.

~~2.4.8~~ 2.4.11 At the second and subsequent special surveys dimensional checks and ultrasonic thickness measurements are to be performed on the diving bell, deck compression chambers and hyperbaric lifeboat compression chamber to the extent necessary to establish any corrosion diminution. Buoyancy aids, cladding and layers of thermal insulation are to be removed for this purpose where necessary~~;~~.

Existing paragraphs 2.4.9 to 2.4.11 have been renumbered 2.4.12 to 2.4.14.

Part 3, Chapter 1
General

■ Applicable Unit Types

The following table details the unit types relevant to each section within this chapter

	Pressure chamber and hull structure	Compression chambers	Diving bell	Doors and access points	Sea transport design requirements	Air transport design requirements	Documentation	Pressure ~~hulls~~ chambers	Submersible hull	Design pressure	Design temperature	Spherical shell/shell sections subject to external pressure	Reinforcement of openings	Design features and loading factor	Submission of calculations	Fabrication and testing requirements
	Section 1	Section 2.1	Section 2.2	Section 2.3	Section 2.4	Section 2.5	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10	Section 11	Section 12
Unit Type																
Manned Submersible	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
Wet Submersible	x	x		x	x	x	x	x		x	x	x	x	x	x	x
Unmanned Submersible																
Submersible Craft																
Diving Bell	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x
Submersible Vehicle																
Submersible Habitat	x	x		x	x	x	x	x		x	x	x	x	x	x	x
Submersible Container																
Passenger Submersible	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
Rescue Submersible	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x

■ *Section 1*
Pressure chamber and hull structure

1.1 General

1.1.10 An appropriate ~~FMEA~~ FMECA (Failure Mode Effect and Criticality Analysis) which includes a safety hazards analysis, shall be carried out by the manufacturer in accordance with IEC 60812 or IMCA D-039. For diving systems an analysis concerning the function and availability of the diving system after occurrence of a single failure is to be submitted for LR review.

■ *Section 5*
Submersible hull

5.1 Design approach

5.1.1 Plating thickness for the pressure hull structure should be sufficient in combination with stiffeners (of suitable geometric proportion) to control overall buckling and orient the first failure mode encountered with increasing design pressure to inter-stiffener buckling.

5.1.2 Ring stiffeners of suitable shape "I" or "T" and suitably sized are to have an effective means of load transfer between the frame and the pressure hull plate. Stability of the stiffeners is to be checked against web buckling/frame tripping.

5.1.3 Frame/web tilting can alter the circumferential stress on the pressure hull plate and therefore adequate safety margins are to be ensured in the frame design. The largest value of bending stress in the frame design in conjunction with the worst buckling mode is

to be considered.

5.1.4 Stiffeners which are external to the pressure hull plating are to be attached to the plating by full penetration welding (as per internal frame stiffeners) to avoid local stress concentration points.

5.1.5 Common sites for discontinuities such as the junction of hemisphere-cylinder/cone-cylinder/cylinder – bulkhead are to be considered during design for suitable strengthening such as providing local higher thickness inserts to minimise the stress /mean stress levels.

5.1.6 Suitable precautions shall be taken such as not to attach structure and components to the knuckle portion of torispherical head so as to avoid the creation of a stress concentration that could adversely affect the structural performance under load.

5.1.7 Buckling response is sensitive to the geometry of the shell. The greater the deviation of the profile from the design requirement the greater the adverse effect on collapse pressure. Design of the pressure hull structure shall be checked for final approval based on the as-built circularity/out of roundness, and any deformed stiffeners including deformations as a result of any external pressure tests.

5.1.8 Internal structures such as transverse bulkheads, decks and tanks are to be adequately designed against instability and buckling due to collapse of the hull structure to which the components are directly connected/welded. Bulkheads and deck plates should be designed against applicable lateral loads. The effect of attachment across the hull diameter may affect the out of circularity due to the interaction with the welded component resulting in lowered collapse pressure. These sites are to be suitably assessed.

5.1.9 Consideration should be given to the indirect attachment of deck plates to the shell, where the deck would otherwise be subject to in plane loads due to shell deflection under hydrostatic pressure.

5.1.10 Consideration should be given to hull girder bending and the resultant stresses to determine if they are significant with respect to stresses from external pressure.

5.1.11 Viewports shall be designed as per *Pt 3, Ch 2 Acrylic Windows* and ASME PVHO-1. Design by analysis may have to be carried out for configurations not covered by code. Deflection of the frame at the sealing area is to be assessed against serviceability limits. The same considerations should be applied to other openings penetrations and hatches as required.

5.1.12 Suitable allowances on scantling thickness shall be provided to compensate for the possible corrosion, erosion and wear and tear during service.

5.1.13 Internal tanks that form part of the pressure hull boundary, and are therefore subject to external pressure should be adequately strengthened to prevent failure due to pressurisation.

5.2 Design Analysis

5.2.1 Analysis shall be carried out to a recognised method from a relevant and recognised international code of pressure vessel design, to determine collapse pressures due to general elastic stability/overall buckling of pressure envelope, symmetric and asymmetric buckling in the interframe areas in conjunction with frame tripping. Additional areas of discontinuities/stress concentration and the effects of external loads should be checked for failure by appropriate analytical methods, where not adequately covered by the pressure vessel codes. The collapse curves used from the pressure vessel code should be an equivalent to the actual material used for hull construction in terms of ultimate and yield strength. A conservative approach should be taken in arriving at the collapse pressure if there are differences in the material properties.

5.2.2 Alternatively the above may be checked by elastic/elastic-plastic FEA, eigenvalue/bifurcation buckling analysis and by elastic-plastic buckling analysis as required, specifically considering the as-built deformed geometry. No strain hardening shall be considered in the elastic-plastic material model.

5.3 Fatigue Assessment

5.3.1 Noting the likelihood of tensile residual stresses in structure created during the fabrication. Suitable consideration should be given to cyclic stresses and therefore fatigue during the life of the pressure hull structure. Fatigue assessment methods as per recognised design codes may be used to arrive at the cumulative damage ratio at the site of peak stress ranges. The magnitude of residual stresses locked in should be suitably considered. A suitable reduction factor of not less than 2 should be applied to overall fatigue life if the components are not adequately protected against corrosion. Further factors should be considered where the locations are not readily inspectable. FEA may need to be carried out to determine the peak stresses at locations not covered by code rules.

5.4 Construction and weld design requirement

5.4.1 The submersible pressure hulls of metallic construction are to be constructed in accordance with the requirements specified in *Ch 13 Requirements for Welded Construction* of the *Rules for the Manufacture, Testing and Certification of Materials, July 2016, incorporating Notice Nos 1&2*, unless more stringent requirements are specified in the applicable design and construction code.

5.4.2 All weld designs for the pressure hull, primary and secondary stiffeners, bulkheads, decks, and other structural members, are to be submitted to LR for approval.

5.4.3 Weld joints of main seam welds and attachment welds shall be staggered and located in such a way to avoid intersection of welds.

5.4.4 All the weld joints within plating and shell cut-out attachments are to be full penetration type with suitable groove/bevel. Penetrations into the shell are to be attached by full penetration groove and fillet weld. The leg length of the fillet should not be the less than the smaller of the thickness of the two parts being joined or as recommended by the applicable code.

5.4.5 Where frames/stiffeners/rings are attached to pressure hull plating by welding, suitable consideration is to be given to the weld profile to avoid stress concentrations. Spacing of the frames should be such that there is access for effective welding and NDE.

5.4.6 Where internal bulkhead/deck plates are to be attached to pressure hull plating, weld types and profiles are to be suitable so as to avoid stress concentrations. Sizing of the weld is to be based on the applicable load with required safety margin.

5.4.7 Caution should be exercised on the use of welds having any form of taper transition and it is recommended that such joints are avoided and replaced by alternative integral design such as forgings etc.

5.5 NDE

5.5.1 All main seam welds are to be examined by RT, 100 per cent, and examined by MT/PT, 100 per cent, for surface flaws or indications.

5.5.2 Attachment welds for shell cut-out and frame/stiffeners are to be examined by UT, 100 per cent, and examined by MT/PT, 100 per cent, for surface flaws or indications.

5.5.3 NDE is to be performed after the completion of fabrication/welding/rework/repair/PWHT, if and where applicable.

5.6 Pressure test

5.6.1 Pressure testing is to be carried out as per *Pt 3, Ch 1, 12 Fabrication and testing requirements* of the Rules, after completion of fabrication/welding and heat treatment, if and where applicable.

Existing Sections 5 to 8 have been renumbered 6 to 9.

■ *Section ~~9~~ 10*
Design features and loading factor

~~9.1~~ 10.1 General

~~9.1.4~~ 10.1.4 ~~Viewing ports~~ Viewports and windows of manned submersibles are to be arranged in positions suitable for the control of the submersible. Where control can be shared between the pilot and another crew member, then both pilot and crew members should be provided with ~~viewing ports~~ viewports having similar views to one another in the forward and one other direction (generally downwards in the case of submersible craft).

Existing Section 10 has been renumbered 11.

■ *Section ~~11~~ 12*
Fabrication and testing requirements

~~11.1~~ 12.1 General

12.1.1 The manufacturer's works are to be approved in accordance with the requirements specified in *Materials and Qualification Procedures for Ships, Book A, Procedure MQPS 0-4*.

~~11.1.1~~12.1.2 All manned chambers under internal and external pressure require the following to be carried out:

(a) 100 per cent radiography on all major welds~~,~~. Welds not subjected to radiography shall be examined by other approved non-destructive testing methods. The use of gamma ray examination may be used only if specifically approved~~.~~;

(b) ~~In~~ in general, 'tell-tale' holes should not be drilled in compensating plates which will be subjected to external pressure. Where 'tell-tale' holes have been drilled in compensating plates, they are to be fitted with taper-screw plugs and seal welded prior to the hydrostatic pressure test, and are to remain efficiently plugged and sealed during service~~.~~;

(c) ~~P~~post weld heat treatment may be required. Each case will be considered individually based on applicable Pressure Vessel Code~~.~~;

(d) ~~D~~diving ~~B~~bells / ~~C~~chambers subject to external pressure are to be subjected to an external test pressure of 1,3 times the maximum agreed working pressure when tested in open water and to an external test pressure 1,4 times the maximum agreed working pressure if tested in the test chamber. Test pressures other than the foregoing will be given consideration~~.~~;

(e) ~~A~~after hydrostatic test, all pressure retaining welds and / or seal welds shall be examined in accordance with the requirements for either magnetic particle examination or liquid penetrant examination~~.~~;

(f) ~~I~~intermediate heads for the pressure chambers should be designed and attached using the adopted national or international pressure vessel design code. In the case where the intermediate heads' attachment are not covered by the adopted code, the

heads may be attached based on the guidance given in ASME PVHO-1. The basic allowable stress will be as per the applicable design code/ standard.;

(g) Sspherical shell and spherical segment head shall be post weld heat treated irrespective of thickness. Heat treatment of the formed heads and the testing of the formed heads material will be considered individually.;

(h) Pproduction tests will be carried out in line with the requirements of the code being followed in agreement with the attending Surveyor.;

~~(i) The works for fabrication of the pressure vessel manufacturing shall be approved by the classification society.~~

~~(j)~~ (i) ~~T~~the lifting block or the reinforcement plate for attaching the lifting block on the top of the diving bell are to have through thickness properties and be subject to appropriate NDE (UT & MT). The attachment welds are to be subject to UT & MT to ~~surveyor's~~ the Surveyor's satisfaction.

Part 4, Chapter 1
Exostructure

■ *Section 2*
Launch and Recovery

2.1 General

2.1.1 ~~The method of launching and recovery pick-up is to be of such a nature that hazards to crew members and recovery staff are minimized~~ Hazards to personnel (including but not limited to crew and recovery staff) during launch and recovery are to be minimised.

Part 5, Chapter 3
Piping Systems

■ *Section 2*
Piping Design Requirements

2.1 Application

2.1.17 ~~Suction ends in compression~~ Compression chambers and diving bells are to ~~be protected against inadvertent covering and suction~~ have suction guards on exhaust line openings inside each compartment.

Part 5, Chapter 4
Life Support Systems

■ *Section 3*
Gas storage

3.1 General

3.1.5 It is to be ensured that gas storage cylinders, and associated valve and piping, are adequately designed against fatigue, as applicable for the proposed dive cycles.

Part 6, Chapter 1
Electrical Installations

■ *Section 7*
Electrical Pressure Hull Penetrators and Cable Connectors

7.2 Routine tests – Penetrators

7.2.2 With the 'gas' side of the penetrator ~~open- ended~~ open-ended ~~an air pressure~~ a helium atmosphere test sequence at not less than twice the working pressure, with a minimum of 6,9 N/mm^2, is to be applied to it. No leakage is permitted. (*See Pt 6, Ch 1, 7.4 Test sequence – Penetrators 7.4.1 (f)* and *(g)*).

■ *Section 9*
Submersibles

9.5 Batteries

9.5.1 In addition to the requirements of *Pt 6, Ch 1, 4 Batteries,* the selection and installation of secondary batteries are to comply with *Pt 6, Ch 1, 9.5 Batteries 9.5.2* to ~~*Pt 6, Ch 1, 9.5 Batteries 9.5.4*~~ *Pt 6, Ch 1, 9.5 Batteries 9.5.6*.

9.5.3 Batteries are to be fixed so as to be undisturbed at the maximum inclination of the unit. ~~Refer to *Pt 5, Ch 1, 2.2 Environmental conditions* and *Pt 5, Ch 1, 2.2 Environmental conditions 2.2.1* and *Pt 5, Ch 1, 2.2 Environmental conditions 2.2.1*~~ Refer to *Pt 5, Ch 1, 2.2 Environmental conditions 2.2.1*.

9.5.6 Where Lithium-ion batteries are to be used inside the submersible hull, a Risk Assessment using a technique selected from IEC/ISO 31010 *Risk Management – Risk Assessment techniques,* or an alternative acceptable standard, is to be performed. The Risk Assessment is to include, but is not limited to:

- cell type;
- battery construction;
- the battery management;
- location;
- ventilation requirements;
- installation; and
- fire.

Part 8, Submersible Systems Specific Requirements
Chapter 1
Overall Design Requirement for One-man Submersible Atmospheric Diving Suit System (ADS systems)

■ *Section 1*
General

1.1 Design basis

1.1.1 Requirements for one-man atmospheric diving suits and supporting equipment are to be as listed below and in accordance with the remaining requirements of these Rules:

(a) one-man submersible atmospheric diving suits shall normally consist of a pressure hull and an exostructure;

(b) the pressure hull and the exostructure shall be:

- so designed that all loads to be exerted on the structure are taken into account. These shall include the most severe loads imposed in normal conditions together with loads resulting from several conditions occurring simultaneously. The planned maximum operating depth and the collapse depth shall be specified;
- the pressure hull joints between moving pressure boundary components of the limbs are to provide a pressure tight seal under all normal operating conditions and have a fail-safe design that, in the event of primary seal failure, will engage a secondary seal that will maintain the integrity of the pressure boundary and will prevent leakage;
- designed where practicable, so that all pipe systems penetrating the pressure hull will be provided with two isolating valves, primary and secondary readily accessible to the Operator, with the primary valve to be immediately inboard of the penetration. Where this is not practicable, all components of the system between the hull penetration and the primary isolating valve shall be designed for an internal pressure of not less than that equivalent to the collapse depth;
- Oxygen cylinders located on board of the ADS are to be stored outside the human occupancy pressure boundary of the ADS. There are to be at least two banks with separate penetrations entering the pressure boundary. These penetrations should be positioned so as to minimise the possibility that a single incident would cause failure of both penetrations. Oxygen pressure is to be externally regulated, such that high pressure Oxygen does not enter the human occupancy pressure boundary of the ADS. The human occupancy pressure boundary of the ADS is to be provided with a pressure relieving device to prevent the internal pressure from rising more than 100 mbar above 1 atm;
- fitted with a lifting point and external structural members capable of withstanding the stresses that may be experienced in service condition in accordance with the *Code for Lifting Appliances in a Marine Environment, July 2016*;
- equipped with at least one alternative lifting point to which attachments may be secured to raise the ADS unit to the surface in an emergency.

■ *Section 2*
Power supply

2.1 General requirements

2.1.1 One-man submersible atmospheric diving suits shall be:

(a) provided with a source of power capable of maintaining normal services for a period adequate for the service envisaged and including the minimum life support requirements set out in *Pt 8, Ch 1, Section 5 Life Support* below;

(b) equipped with means of propulsion adequate for the service envisaged.

2.1.2 Where electrical power is used, the suit shall be:

(a) fitted with equipment compatible with the special conditions pertaining to marine service, where practicable all equipment shall be continuously rated;

(b) provided with adequate electrical protection;

(c) fitted with effective means of isolating all poles or phases from every circuit and sub-circuit as may be necessary to minimise shock hazard;

(d) fitted with circuits which do not use hull return;

(e) provided with an earth leakage measuring device;

(f) fitted with gas control safeguards, where applicable, on the compartments containing the power source.

■ *Section 3*
Auxiliary systems

3.1 General requirements

3.1.1 Atmospheric diving suits shall, where appropriate:

(a) contain valves, gauges and such other equipment as are necessary to control the propulsion and auxiliary systems, including any fuel supply and exhaust systems;

(b) contain such valves, gauges and other equipment as are necessary to control the depth, attitude, and rate of descent and ascent without inducing resonant or unstable motions;

(c) The ADS is to be provided with an emergency surfacing system, be fitted with jettisonable weights or other means, suitably protected against inadvertent operation, to achieve positive buoyancy in an envisaged emergency. This system is to permit the ADS to ascend to the surface when disconnected from its tether/umbilical. The system is to provide positive buoyancy sufficient to ascend to the surface from any operational depth. Emergency surfacing system activation is to require at least two positive manual actions for operation and is to be independent of electrical power. Emergency ascent calculations (addressing the net positive buoyancy provided and the resultant ascent rate) are to be submitted for review and approval. The emergency surfacing system is to operate properly under all anticipated conditions of heel and trim;

(d) be fitted with valves or other fittings to enable manipulators, grasping or anchoring devices and jettisonable equipment to be released in a planned or envisaged emergency;

(e) the ADS is to be configured such that it will automatically and naturally assume a normally upright or comfortable position, when not influenced by the pilot's body motion or thrusters;

(f) the ADS stability analysis, test procedures and test results are to be submitted for approval;

(g) be fitted with an umbilical capable of maintaining services and of sufficient strength for its intended service;

(h) be equipped with an internal release, suitably protected against inadvertent operation, for severing or releasing the umbilical cable.

■ *Section 4*
Buoyancy and Stability

4.1 General requirements

4.1.1 One-man submersible atmospheric diving suits shall, where appropriate, have sufficient buoyancy and stability to enable a properly trained person to operate it in all sea states and conditions for which it is intended.

4.1.2 Instructions showing operating procedures shall be provided for each suit in intended service conditions together with emergency procedures. The instructions shall take into account the fully submerged and transient submerging and surfacing conditions together with a full buoyancy condition. The effects of releasing any jettisonable devices either individually or in combination shall be taken into account.

■ *Section 5*
Life Support

5.1 General requirements

5.1.1 One-man submersible atmospheric diving suits shall be provided with the on-board emergency means of life support to maintain the occupant in a safe and breathable atmosphere for a minimum period of 24 hours.

5.1.2 One-man submersible atmospheric diving suits shall:

(a) Contain adequate equipment to maintain a safe and breathable atmosphere in the Operator's compartment. Where electrical power is used, the equipment shall be capable of functioning whether or not the main electrical power source of the suit is operable;

(b) contain monitoring devices to test the atmosphere in the Operator's compartment;

(c) The ADS is to be provided with the following instrumentation for monitoring the life support conditions within the human occupancy pressure boundary of the ADS:
  (i) Oxygen analyser;
  (ii) Carbon Dioxide (CO_2) analyser;
  (iii) temperature measurement device;
  (iv) suit internal pressure gauge.

  In addition to the above instrumentation, displays or gauges are to be provided to show the breathing gas storage cylinder supply high pressure and regulated low pressure supply to the human occupancy pressure boundary of the ADS;

(d) at all times carry emergency supplies of food and water to sustain the occupant for the period of 24 hours or as specified by the administration;

(e) contain the minimum of flammable and toxic materials, *see Pt 5, Ch 6 Environmental Conditions*;

(f) the ADS is to be provided with the appropriate equipment to generate, monitor and maintain suitable life support conditions inside the human occupancy pressure boundary;

(g) the ADS is to be designed so that the concentration of O_2 (Oxygen) will be kept within the limits of 19,8 to 22,0 per cent by volume;

(h) the ADS is to be designed so that the concentration of CO_2 (Carbon Dioxide) will never exceed 0,5 per cent by volume referenced to standard temperature and pressure except in emergency conditions, *see also Pt 8, Ch 1, 6.1 General requirements 6.1.5*;

(i) The ADS designer is to specify the normal ADS mission duration (including working and resting periods) as well as the reserve duration, along with the associated metabolic parameters that are applied to each of these durations. The normal life support system is to have sufficient life support capacity for the anticipated maximum mission duration, including consideration of the metabolic workload(s). The anticipated maximum mission duration is to be defined by the ADS designer, but is not to be less than 6 hours. The normal life support system is to include two independent Oxygen banks (supplies) and piping systems. One of the two independent Oxygen banks is to have sufficient Oxygen capacity to support the anticipated maximum mission duration. The remainder of the Oxygen capacity in the two independent banks (after considering the anticipated maximum mission duration) is to be sufficient to support the reserve mission duration as defined in these Rules. The normal life support system is to include at least one Carbon Dioxide (CO_2) removal system. The scrubber of the CO_2 removal system is to have sufficient absorbent material capacity to support the anticipated maximum mission duration as well as the emergency duration defined in these Rules. The CO_2 removal system may consist of a powered blower type circulation system or a lung-powered arrangement using an oral-nasal mask or a full-face mask.

■ *Section 6*
Emergency Life Support

6.1 General requirements

6.1.1 The ADS is to be provided with an on-board emergency life support capacity.

6.1.2 The reserve life support capacity is to be sufficient for a duration that is consistent with the emergency rescue plan but is not to be less than 24 hours (over and above the anticipated maximum mission duration).

6.1.3 Actuation of internal controls intended for emergency operation is to be fully manual.

6.1.4 For emergency operation, the CO_2 removal system is to be capable of being used in a lung-powered mode using an oral-nasal mask or a full-face mask.

6.1.5 Under emergency conditions, the CO_2 removal system is to be capable of maintaining the concentration of CO_2 below 1,5 per cent by volume.

■ *Section 7*
Communications

7.1 General requirements

7.1.1 One-man submersible atmospheric diving suits shall be fitted with suitable equipment as is necessary for the submersible suit to communicate with its parent craft when on the surface and when submerged. Equipment using through water communication methods shall have a minimum range of twice the maximum operating depth of the suit under the expected operational conditions.

7.1.2 Where main communications are transmitted through the umbilical, emergency through water means of communication shall also be provided.

■ *Section 8*
Navigation and position indication

8.1 General requirements

8.1.1 One-man submersible atmospheric diving suits shall be:

(a) fitted with an efficient compass;

(b) provided with an adequate means of visual look-out ahead of the suit;

(c) fitted with such gauges or instruments to provide a continuous read-out of depth to the Operator;

(d) fitted with a visual means of position indication for use on the surface, including highly visible paint, and strobe light;

(e) fitted with a sonic location device with frequency of 37.5KHZ as per IMO resolution A.831(19) code of safety for diving, to provide position indication in an emergency when submerged.

■ *Section 9*
Supporting Equipment: Launch and Recovery System

9.1 General requirements

9.1.1 One-man submersible atmospheric diving suits shall be so constructed as to be capable of use in association with a lifting gear system which enables the suit to be lowered into and recovered from the water with adequate safety factors for the intended service.

9.1.2 If wires or ropes are incorporated for hoisting or lowering any submersible suit, these shall have safety factors based upon the proven or calculated breaking strength of the wire or rope.

9.1.3 The ADS is to be provided with primary lifting lugs or attachments designed to support the entire weight of the ADS including the weight of the equipment, supplies and pilot within the ADS. They are to be designed for forces of at least 2g vertical (1g static plus 1g dynamic), 1g transverse and 1g longitudinal, unless otherwise determined by the designer, acting simultaneously under the most severe loading condition. Where appropriate, the increased loading due to other applicable loads such as added mass including flooding of the compartment and drag are to be also considered.

9.1.4 Additional lifting lugs or attachments are to be provided for emergency recovery of the ADS. The emergency lifting lugs or attachments are to be designed for lifting and raising the ADS to the surface under the heaviest emergency condition following an accident.

9.1.5 The lifting gear system shall be subjected to static and dynamic load tests.

■ *Section 10*
Tests

10.1 Tests and test dive

10.1.1 The human occupancy boundary of ADS is to be subjected to a hydrostatic proof test as per *Pt 3, Ch 1, 12.1 General 12.1.2(e)*.

10.1.2 Each ADS is to be subjected to a test dive to the design depth in the presence of the Surveyor. The test dive is to be conducted with the ADS manned to verify proper operation of the joints and controls at depth.

10.1.3 Where the depth of water available is less than the design depth, both the rated depth (depth reached during test dive) and the design depth will be indicated in the record.

10.1.4 Each ADS is to be subjected to manned functional test in the presence of the Surveyor. The functional test is to demonstrate satisfactory performance of life support systems, position control and steering systems, electrical systems, and other items required for safe operation of the ADS. The testing may be conducted at shallow depths or test tanks.

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